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ABSTRACT

The paper discusses the provision of biology education to handicapped students in terms of teacher preparation, student instructional materials, and existing science programs. Among the programs available for the teacher who wants to teach science to handicapped students are NUSTEP (Nebraska University Secondary Teacher Education Project) and American University's Development Techniques in Teaching Laboratory Science to Blind, Deaf, and Emotionally Disturbed Children. Literature reveals a number of barriers to science education for the handicapped, including low teacher expectation, negative societal expectations and personal aspirations, and lack of role models. There are three commercially available science programs for elementary level handicapped students--Adapting Science Materials for the Blind, Science Activities for the Visually Impaired, and ME NOW for the educable mentally retarded. Some examples of activities include identifying examples of plant and animal adaptations favorable to food gathering and protection in different surroundings, identifying examples of adaptations that provide protection from being killed and eaten, and identifying examples of how humans have changed their surroundings to provide food and protection. Listed among 15 suggestions useful for teachers of science to successfully motivate and challenge students are given the child tasks in which he can be successful in completing, let the child know that it is alright to make mistakes while participating in science activities and doing experiments, and make use of peer tutoring. (SB)

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# Biology Education for Handicapped Students

Adell Thompson

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Biology Education for Handicapped Students

Handicapped students have a right and a need to learn basic biology content and skills. Evidence indicates that handicapped students are interested in, and capable of, learning biology. Handicapped students have similar needs to those of non-handicapped students, therefore it is necessary that equal educational opportunities be offered to them.

Biology courses should be an integral part of all handicapped students through high school. Physically handicapped students should receive the same comprehensive exposure to various fields of science as do non-handicapped students. Aspects of the science curriculum should include process, content, and career education with emphasis placed on early childhood and elementary programs, as well as middle/junior high school and secondary school science programs. The teacher who teaches biology to the physically handicapped must possess a strong comprehensive biology background. Biology teachers utilizing multi-sensory instructional techniques and laboratory-centered programs are able to effectively teach physically handicapped students in regular classes or special classes. The instructional strategies, techniques, and procedures found to be effective with the physically handicapped in biology are those found to be effective with the non-handicapped student. A great need exists for the dissemination of educational information about biological materials, teaching aids, techniques, conferences, workshops, etc. to both the regular and special education teachers who teach biology to the handicapped student.

Conceptual and practical experiences assist all students in preparing for life. If educators will help the handicapped to understand, use and appreciate science, then these students may be more able to consider biology or related fields as career possibilities. Biology is a vehicle for the development of

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learning skills in students. The study of biology helps meet the psychomotor, psychological, and social skill development needs of both the handicapped and non-handicapped student.

The goal of providing a meaningful education for handicapped students in an appropriate environment is meaningless unless teachers have the knowledge, skills, and attitudes essential for the implementation of desirable programs. In the past, teacher education programs have not systematically included the teaching of handicapped students as an integral part of the preservice program for regular classroom teachers. Preservice programs are now being modified to include the teaching of handicapped students in the regular classroom as an essential part of the teacher preparation program.

What does mainstreaming mean to the science teacher? It means that science teachers may have special students with various types of handicaps in their regular classes, and that they have to include the handicapped student in regular class activities and set a wide range of competence goals for the class which include the special student. Teachers will have to assess the ability of the student and consider realistically how the student's handicap does or does not affect his or her ability to do science. The teacher may have to locate or adapt science materials for the particular disability of the student. Because of the extra work involved in doing this, the teacher may be tempted to exclude the special student from the "hands-on" part of science. But a broad range of science experience, both theoretical and practical, is necessary to guide the handicapped student toward an understanding and an appreciation of science or even the possibility of choosing science as a career.

Too often you hear teachers, who have handicapped students placed in their classrooms ask the question, "What do I do with them?" Teachers will

have to assess the capabilities of the handicapped student and realistically consider how the student's handicaps did or did not affect his/her ability to learn science. According to Kolden and Malcom (1976), teachers would have to locate, adopt, or create science materials and activities according to the particular need of the student.

There are very few programs available for the teacher who wanted to be prepared to teach science to handicapped students. The University of Nebraska-Lincoln developed a unique pre-service program NUSTEP (Nebraska University Secondary Teacher Education Project). NUSTEP (McCardy, 1978, pp. 45-46) addressed itself to the issue of teacher preparation. It was a nine semester hour block course including special methods, learning theory and principles, and a pre-student teaching practicum experience. Students spent one-half semester on campus in individual activities and group work, the other half in a public school where they functioned as teaching assistants. In classroom teams, they tutored, set up laboratory activities and ultimately instructed the entire class. NUSTEP was organized into modules. All the generic and many of the subject area modules contained references and exercises related to various handicapping conditions. Simulated problems were discussed and opportunities provided to adapt various laboratory activities. Module VI, Individual Differences, created a mainstreaming situation and required student responses.

Another pre-service teacher program was offered at the American University in Washington, D.C. The program was entitled, "Development and Techniques in Teaching Laboratory Science to Blind, Deaf, and Emotionally Disturbed Children." Designed especially to implement Hadary's laboratory science and art program for the blind, deaf and emotionally disturbed (Hadary and Cohen, 1978), the program content included subject backgrounds in physics, chemistry and biology; a rationale for teaching science and art

to handicapped students. The basics of learning theories, adapt education curricular design and equipment; teaching strategies in a mainstream setting; research studies on handicapped students; and the effects of concrete operational approach on the development of logical reasoning by the handicapped student. Methods employed included lecture, discussion, laboratory, seminars and ultimately, a practicum with mainstreamed blind, deaf, and emotionally disturbed students under the supervision of master teachers.

Another service available to the teacher was the National Information Center for Special Educational Material (NICSEM) (NIMIS, NICSEM, 1978). NICSEM functioned as a data base for special education materials with provisions for manual and computer searches. A master catalogue was available with six cross referenced indexes in Learning Disabilities, Mental Retardation, Speech and Hearing, Emotional Disturbance, Physically Handicapped/ Health Impaired and Visually Handicapped.

There are two major organizations in science and science education supportive of science for the handicapped: The American Association for the Advancement of Science (AAAS) and the National Science Teachers Association (NSTA). Both the AAAS and the NSTA supported educators of the handicapped through the sponsoring of national conferences. In 1976, the AAAS annual meeting in Boston, Massachusetts, was entitled, "Science Technology and the Handicapped" (Redden & Schwardt, 1976). The symposium explored technological advances being made for the handicapped and the architectural, transportation, and career barriers being overcome by the handicapped scientist. The NSTA sponsored a working conference on Science Education for Handicapped Students in 1978 in Washington, D.C. prior to the NSTA annual meeting (Hofman, 1978, p. 1). Educators made an assessment of the state of science education for the handicapped, made recommendations from their findings and vowed to work for better quality science education for physically handicapped students. At

this point in the evolution of science for the handicapped, it appears that national conferences provide the most direct link between researcher and practitioner, program developer and program utilization.

The literature revealed that there were many barriers in science education for the handicapped. In addition to outside influences such as low teacher expectation and parental over-protection, the handicapped child had to cope with a deprivation of science content in schooling, negative societal expectations and personal aspirations, and a lack of role models (Dodd, 1978, p. 147). Science had not been traditionally taught to handicapped children for various reasons--including some of the same ones used for not teaching science to non-handicapped elementary children (Ankey and Rogers, 1976, pp. 9-11; Menchel, 1978, p. 15). These reasons included: (a) Time is a premium and other subjects are more important than science; (b) budgets are limited and science requires expensive equipment; (c) science is considered a difficult subject which can only be mastered by a few "good" students, not all students; (d) people who succeed in science are stereotyped as intellectuals, males, and non-handicapped; (e) teachers feel inadequate in preparation and knowledge of the subject matter of science and scientific methods. The new trend of inquiry-discovery science is threatening. Hence, teachers teach science the way they have been taught, mainly through the use of textbooks as the predominant instructional medium, with the lecture-discussion method following. This produces a subject that is not "fun", and consequently students are not interested in science.

Particularly in regard to the handicapped student, children may have been discouraged by negative experiences which have actually occurred due to skeptical teachers or laboratories ill prepared to handle them. Perhaps through limited resources or a lack of teacher imagination, the handicapped child may have experienced failure in science (Rehwoldt & Samoff, 1978, p. 132). Others may have had a non-handicapped partner dominate the laboratory

activity while the handicapped partner became the spectator who not only missed the thrill of discovery, but failed to develop laboratory techniques necessary for later work in science. One approach often found was the protectionist approach where the handicapped child was excused from doing certain experiments or waived out of entire courses (Thier, 1978, p. 115).

Reactions of handicapped students include the feeling of embarrassment over a disability that required adaptation or modifications in laboratory situations. Fear of failure was experienced, especially if the handicapped person came from a very sheltered situation where competition was downplayed and the threat of failure small. Swazuk (1978, pp. 57-61) affirmed that the handicapped child was often not academically or experimentally on par with students having regular science periods or where science had been sequentially developed over a period of years.

There are at present three commercially available science programs for handicapped elementary children. They are: Adapting Science Materials for the Blind (ASMB), Science Activities for the Visually Impaired (SAVI), and ME NOW for the educable mentally retarded. The teaching strategy of ASMB was for children to "explore selected science materials, be encouraged to investigate, discuss what they observed, and to ask questions" (Thier & Hadary, 1973, p. 8). The teacher was to be: an observer who listened to the children and noticed their progress and to be a guide who led the children to see the relationships of their findings to certain selected concepts of science.

SAVI purported to emphasize "what the visually impaired child <u>can</u> do" (Thier, 1978, p. 115). Utilizing all their available senses, it stressed a multi-sensory approach to science and capitalized upon the strengths of the visually impaired. Feeling, hearing, tasting, and touching dominated all the activities, but residual sight was encouraged whenever available. Once

again, as in ASMB, the program developers saw the visually impaired child as "normal" except for his/her lack of sight. The science concepts and skills taught remained the same for both the handicapped and non-handicapped child. An interesting sidelight to the program was that the developers of SAVI urged all children, including the sighted, to use the program. They advocated a return to the senses for every child, not just the impaired. They felt that senses other than sight had been under-developed in most children and could be untapped modes of learning. Schaur and Berger (1978, pp. 123-124) witnessed occasions when regular teachers became interested in SAVI after seeing its success and approached the special teachers to learn more about it.

ME NOW began by identifying learning characteristics of the EMR population. In addition to certain general characteristics (Whorton, Reichard & Reid, 1971), the advisory groups also categorized some specific learning characteristics involving: retention; transfer of learning; learning set; auditory and visual discrimination; reaction time; creativity; and incidental learning. The educational implications of these characteristics or readiness, motivation, need for immediate feedback of results, repetition, practice and exercise, pacing, student participation, minimal change, and accuracy and speed were studied (Shepard, 1970, pp. 7-8). The philosophy of ME NOW stated that "all children are entitled to equal opportunities for self-development of the fullest extent of their individual physical, mental, and emotional capabilities" (Cleaver, 1971, p. 2). This was to be done through a program designed especially for their needs and abilities. The goals of such a program were to be concept mastery and personal satisfaction. The ultimate success of the program was stated to be a function of the inventions and improvements of the teachers and curriculum designers.

Three well-known science programs: the Elementary Science Study (ESS), the Science A Process Approach (SAPA), and the Science Curriculum Improvement

Study (SCIS) have been adopted for use with handicapped students. Particularly SCIS, because ASMB originated from an adaption of SCIS, while SAVI evolved from ASMB. ME NOW arose from a need for a program for EMR students and was developed specifically for them. It had no pre-existing model. All of these programs used professionals in the stages of conception, development, and revision, but only ME NOW provided an intensive, in-service, consultative follow-up with experienced field personnel and monthly newsletters. ME NOW producers acknowledged that special education teachers hesitated to teach science due to many factors (real and imagined) and that regular teachers with handicapped children were unsure of group characteristics and special education techniques. By providing both special and regular teachers with extensive background information, they emphasized the fact that any program is only as good as the teacher presenting it. Here are some examples of activities.

## Identifying Survival Adaptations

General overview. Survival of the fittest is a key concept that refers to living organisms being favorably adapted to their surroundings. Organisms that can produce life's necessities, avoid being killed, adjust to changes in the physical environment, and reproduce their young are described as being adapted to their environment. Elementary students can identify examples of adaptations favorable to survival of living things even though they cannot yet comprehend the genetic factors operating. Students can also extend examples of adaptive survival to human activities. It is important during these lessons to avoid teleogical references such as "Giraffes developed long legs in order to get food from trees."

Learning objectives. Students will identify examples of plant and animal adaptations favorable to food gathering and protection in different surroundings. They will extend their examples to humans.

Objective. Identifying examples of adaptations for gathering or making food.

Teacher preparation. Have available films and reference books on plants and animals in different environments for use the entire week. Introduce the concept of plants and animals exhibiting adaptations that are favorable for making food (plants) and gathering food (animals and fungi). Provide some examples, such as a plant bending toward light, snake venom, and the long necks of giraffes. Ask students to suggest other examples. List these suggestions on the chalkboard and solicit student ideas for grouping the adaptations into categories, such as: speed, sensory ability, body structure (claws, fangs, beaks, teeth), trapping ability (webs, poison, stickiness).

Activities. Students use reference materials to identify additional examples of adaptation for gathering or making food and list them according to categories.

Objective. Identifying examples of adaptations that provide protection from being killed and eaten.

Teacher preparation. Introduce the concept of plants and animals exhibiting adaptations that provide protection from being eaten. Provide some examples, such as thorns on plants and the odor of skunks. Ask students to suggest other examples. List their ideas on the chalkboard and solicit student suggestions for grouping them into categories such as: protective colors, hard and thorny surfaces, protective noises, poisons, sensory adaptations, size, and speed.

Activities. Students use reference materials to identify additional examples of adaptations that provide protection from being eaten. They discover that some adaptations that are favorable for gathering or making food are also favorable for protection from being killed and eaten.

Objective. Identifying adaptations favorable to living in different surroundings.

Teacher preparation. Introduce the concept of plants and animals exhibiting

adaptations that are favorable to different degrees of light, heat, water, air, and soil types. Identify those as the physical factors in our surroundings or physical environment. Provide some examples of living things adapted to the physical environment, such as gills in fish which obtain oxygen in water, blubber on whales which provide protection from the cold artic waters, webbed feet on ducks, succulent plants in the desert, and lichens growing on bare rock. List additional adaptations identified by students on the chalkboard or posterboards.

Activities. Students use references to identify additional examples of adaptations favorable to living in different surroundings.

Objective. Identifying examples of adaptations that provide protection from changes in physical conditions.

Teacher preparation. Lead a brief discussion of living things exhibiting adaptations to changes in their physical environment, such as seasonal migration of birds and other animals, day lilies opening up in sunlight, bats coming out at night, waxes and oils on animal fur and skin which repels water, water-storage cells in cactus plants, seasonal changes in deciduous trees, and changes in animal coloration. List additional adaptations identified by students on the chalkboard or posterboard.

Activities. Students use reference books to identify additional adaptations to changes in the physical environment.

Objective. Identifying examples of how humans have changed their surroundings to provide food and protection.

Teacher preparation. Lead a brief discussion on human adaptations favorable both to obtaining food and to avoiding being eaten by other animals. Ask students to identify how different groups of people have modified their environment to ensure more efficiency in food gathering. Also ask them to identify how different groups of people exhibit adaptive characteristics favorable to

different physical environments, such as black skin in tropical zones. Engage the students in a discussion of how different peoples have created ways to protect themselves from changes in the physical environments, such as heated and cooled buildings, electrical lights, and flood levees. List student suggestions on the chalkboard or posterboard for each area discussed.

The experiments mentioned are only samples or suggested activities which can be carried out by both regular and handicapped children in the classroom. Perhaps the effect of how such experimental activities motivate handicapped students can be summed up in the following passage:

A junior high school student who spent long hours designing mathematical formulas, computers, and elaborate electronic devices which were based more on fantasy than on fact. His resourceful teacher, however, gradually got him interested in constructing a simple buzzer which operated on a dry cell battery. Despite the student's preoccupation with electronic wizardry, he was led patiently through the buzzer-making project and actually finished it. When a "loud buzz" ensued on the day of completion, the boy was obviously very delighted. He displayed the buzzer with pride to his classmates and later confided to the teacher, "Do you know that this is the first thing I ever planned and made that actually worked?"

The predictability associated with science demonstrations and experiments is seen as very valuable in classrooms for handicapped children since their backlog of failures is greater than their backlog of successes. For this reason, every effort should be made to select activities that are simple yet intriguing to children and which have a high probability of success in the classroom.

What Teachers can do in Structuring for Success in Teaching Science

Teacher success is related to student success. However, the success of all students often depends upon teaching strategies. Dedicated teachers, in

science and other areas, are concerned with how best to minimize lines of division between regular classroom students and handicapped students. Although in regular classroom situations some students experience frustration, the conditions become worse when handicapped children also in the class become confused. Two problems may arise for the handicapped students, one of not being familiar with working in a regular classroom, and the other of not being able to master, in this case, the science lesson as being presented. Because of this situation, many teachers request ideas that help bring exciting learning opportunities and signals to all students. Learning science need not be a boresome and distasteful experience. Justifiably, teachers want a science curriculum that moves all students forward during the year--in academics, in accepting responsibility, in working with others, and in understanding their own actions and thoughts. "We can learn science, too" is telling science teachers that real life itself is filled with numerous series of short-term and long-term activities, with variety and with a multitude of "things". Handicapped children should not be denied the excitement of creative and basic school-type activities in science or any other subject: rather, all students should be given numerous content-area themes to investigate. To do this, teachers desire suggestions in a succinct fashion.

In the following section of this paper we will briefly list what we believe to be helpful information for teachers of science to successfully motivate and challenge all their students in the classroom.

1. Give the child tasks in which he can be successful in completing. This may mean providing prompts or cues when necessary to lead the child to the correct response.
2. Reinforce correct responses immediately in the form of social approval or some tangible object or tokens.
3. Provide the child tasks that are not too easy nor too difficult.

4. Provide instruction systematically by proceeding in a step-by-step fashion so that basic material is learned before more difficult material is attempted.
5. Limit the number of concepts presented to the child at one time.
6. Provide materials which appeal to all the sensory modalites--visual, auditory, tactical, kinesthetic.
7. Let the child know that it is alright to make mistakes while participating in science activities and doing experiments.
8. Audio visual presentation. Use movies, slides, filmstrips, video, radio transparencies, records, etc.
9. Provide ample time for instructional and practice time before a new skill or concept is mastered. Handicapped children may require more time to learn the technical vocabulary and the manipulation of scientific apparatus.
10. Make use of peer tutoring. To be asked outside of class.
11. Make use of the buddy system. To be used in the classroom.
12. Use of question and answer sessions in the classroom. This "give" of classroom discussions frequently is the teacher's ability to guide the student's thinking through the use of questions.
13. Develop learning centers.
14. Provide for discovery learning. Give students a problem situation where no procedures are established. Ask them to develop their own method for finding solutions, facts, or drawing hypotheses.
15. Use supplementary texts and other written material. Also use high interest and low vocabulary materials.

Realizing that many teachers, supervisors, and principals may not be familiar with workable strategies to employ to teach science to handicapped children in the regular classroom we have shown through the use of multi-sensory experiences how children may learn about the environment in which they live.

An environmental curriculum offers an alternative strategy for presenting science skills, concepts, related activities, and experiments for handicapped and non-handicapped children. Such a program provides opportunities for encouraging interpersonal skills between these children in a regular classroom situation. Experimental manipulation of air, light, soil, and water--the basic elements necessary for life form a conceptual basis for instruction through which all children were successful in exploring the natural environment.

## Conclusion

I have indicated that special education is in a period of transition. Supported by demands of parents and legal mandates, all handicapped children will be served in the least restrictive environment with programs designed to meet their individual needs. Biology teachers must be prepared to receive handicapped students into their classrooms and to teach them biology. They will need specially adapted programs and innovative laboratory techniques. Where none exist, they will have to create them. Teachers must be aware of the characteristics of the students they will be working with, and be attuned to programs or procedures which enhance the student's assets and compensate for their liabilities. No longer can handicapped students be denied access to science through attitudinal or curricular barriers. The right to learn science and apply it to life or a career is now a reality for all handicapped students.

In the past, educators lack of interest in science for the handicapped and their belief that these students were incapable of performing science, accounted for the lack of research in this area. No longer will this be a valid excuse. While it is true that some persons in the field are exploring science for the handicapped, more needs to be done. As evidenced from the review of the state of the art of science instruction for handicapped elementary children, the task will be an arduous one. At present, a few programs are available, but most are not highly publicized, nor are they backed with the experimental finesse found in other science programs for the non-handicapped.

There is a real need to develop pre-service and in-service programs to prepare all teachers for the entrance of handicapped students into their classrooms. Teachers need to be familiar with the characteristics of handicapped students and effective teaching strategies to be used with these students.

Learning assets need to be considered as well as learning liabilities. Special teachers need more background on teaching laboratory science and all teachers need to be aware of special programs or techniques. More research is indicated in the area of acceptable special science programs and their spectrum of utilization. Special science programs developed for certain handicapped students need to be tested in classrooms of students with other handicapping conditions. Data needs to be collected on the efficacious use of not only science instruction for handicapped students, but which science instruction or programs which work well with groups not designated as target populations. The possibility of non-handicapped students benefiting from certain special science probrams needs to be evaluated.

Students must be seen as individuals, with certain individual academic, behavioral, and personal characteristics and it is these characteristics which should be matched to a program, not vice versa.

Regular education has taught special education many things. Now is the time for special education to expand its exploration and acquisition of knowledge and technology to provide not only for handicapped students, but for all children with special needs.

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